Articulate the Role of Scouts in the Overall Mars Exploration Program

A Status Report Presented to the

NASA Robotic and Human Exploration of Mars
Strategic Roadmap Committee
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The Agenda

- Scout Program Characteristics
- Improvements Needed for the Current Scout Program
- Potential Human Exploration Precursor Utilization of Scout-class Missions
- Driving Considerations
- Options for Integration of Human Exploration Precursor Requirements into a Scout Program
- Conclusions and Preliminary Recommendations

This is a Work in Progress

Scout Program Characteristics

- Goal: Scientific discovery through community-driven missions
  - Entrepreneurial Science at its Most Basic Level – Solicit Innovative Ideas
  - Rapid Response to New Discoveries
- Ground-Rules & Objectives:
  - Competitively selected missions from the Mars, Astrobiology and related scientific communities
  - Broad scientific needs defined in a competitive AO call; “wide open” competition
  - Fly Every Other Opportunity
  - Cost-Cap $325M (Including LV)
  - Use Mature Technology (TRL 6 or Higher)
- Budget FY06 – FY10 is ~ 17% of Mars Program

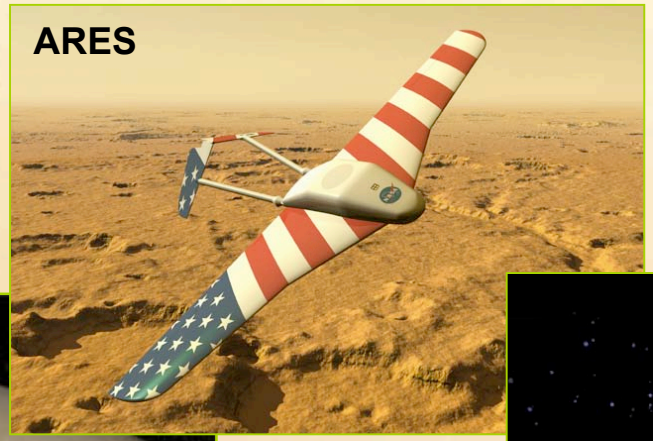
Scout '07 Solicitation Summary

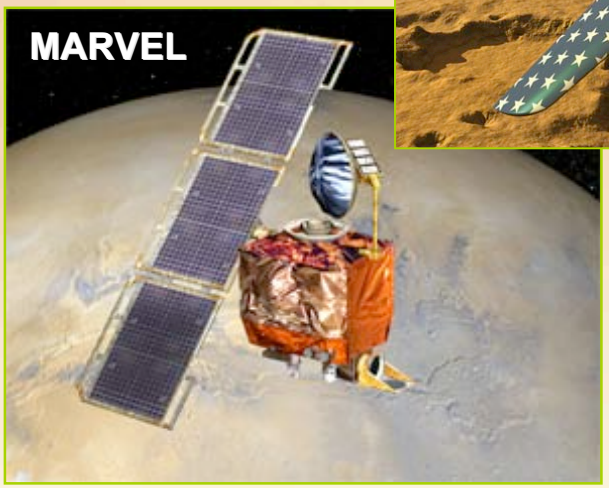
- 25 Proposals Submitted
- 23 Proposals Passed Compliance Check
- 5 Missions of Opportunity
- 18 Full Mission Proposals
  - 2 Orbiters
  - 6 Stationary Landers
    - Including 2 Drilling Platforms and 1 Cryobot Platform
  - 3 Rovers (including Microrovers)
  - 1 Network of Small Landers
  - 1 Network of Penetrators
  - 4 Aerial (1 Gliders, 2 Balloons, 1 Airplane)
  - 1 Atmospheric Dust Sample Return
- First Round Results
  - 4 Selected for Detailed Study
  - Phoenix Selected for Implementation

2007 Competed Scout Mission

Incorporate into the Mars Exploration Program innovations in science, measurement systems, and mission concepts.

A competitive process to select scientist-led missions





Scout Program Improvements Needed

- Current Scout Cost Cap Considered Too Low for Some Viable Mission Types (Especially Landers)
- Need Improved Cost Realism and Reduced Risk at Selection
  - Multiple-step Down-select – Details Need Study
  - Fund ~4 teams for 6-9 Month Phase A (Step 2) for $500K-1M Each
  - Down-select to 2 Teams to go to (minimum) PMSR (or to a "pre-PDR") – Time and Dollars TBD, but Likely $5 -15M Each. Select One. The Return-on-Investment is Positive:
    - Reduce Cost Overruns by More Than Investment
    - "Loser" Now Better Prepared for Next Cycle
  - Include Directorate Independent Cost Analysis Prior to Final Down-select
- Review & Analyze NRC PI-Led Mission Study for Relevance to Scout

Potential Human Exploration Precursor Utilization of Scout-class Missions

- MEPAG Goal IV Revision Underway
  - Measurements Needed for Engineering Decisions, e.g.,
    - Atmosphere Characteristics
    - Dust Properties
    - Chemical Properties of Regolith
    - Water Location, Accessibility (Water, Ice, Hydrates, etc.)
  - Engineering and Technology Demonstrations, e.g.,
    - Aeroassist (Aerobraking to Aerocapture)
    - In-Situ Resource Utilization
    - Materials Response to Mars Environment
- Some Goal IV Measurements/Demonstrations Can Be Met by:
  - Scout-Class Orbiters, e.g., Atmosphere Characterization, SAR
  - Scout-Class Landers, e.g., Met Stations, Penetrators, MicroRovers
- Many Goal IV Requirements Require Larger "Testbed-Class" Landers and Rovers
- Use Payload-of-Opportunity Approach in Solicitations

Driving Considerations

- The Cost of Going to Mars is Inherently High (Launch, Lengthy Operations, Orbit Insertion, EDL, DSN)
  - "Soft" Landers Require Higher Cost Caps Than Orbiters and May Need Innovative Mission Approaches
- A Mars Exploration Program Must Look for Most Economical Way to Obtain Results
  - Look for Mission Synergies
- An Integrated Robotic Science-Human Exploration Program Sets the Tone for Incorporation of Science into the Human Exploration of Mars

Options for Integration of Human Exploration Requirements into a Scout Program

1. Maintain a “Pure Science” Scout Program & Initiate a Human Exploration Precursor Scout-Class Program Under the Testbed Line
2. Accommodate Some Human Exploration Precursor Requirements into One Broadened Scout Program
   - Make Human Exploration Goals Part of the Competitive AO
   - Address as many Human Exploration Precursors as Possible in Science Scout AO calls
   - Maintain the Potential for International Contributions (Both Directions)

Conclusions and Preliminary Recommendations

Conclusions

- A Scout-Class Component to the MEP is Important and Critical to Mars Scientific Discovery
- Scout-Class Missions Can Acquire Some of the Data Needed by the Mars Human Exploration Precursor Program

Preliminary Recommendations

- Continue Science-based Scouts AND Execute selected Human Exploration Precursor Testbeds
  - Maximize Synergy and Efficiency
  - Ensure the Capacity for Science-dedicated Missions
  - Ensure the Capacity for Precursor-dedicated Missions
  - Encourage and Enable Accomplishment of BOTH Requirements as Joint Priorities Allow
  - Allow broad spectrum of proposals, including payloads of opportunity aligned with Mars goals

Conclusions and Preliminary Recommendations

- Adjust Current Scout Program to Reduce Development Risk
  - Competitive, Well-funded Multi-step Phase A/B studies “almost” to PDR
  - Implement Independent Directorate Cost Assessment Prior to Final Selection
  - Increase the Funding Cap ($XXX to XXX, Excluding Launch Vehicle)
    - Commission Independent Analysis to set Cap, as well as Step Funding Levels
- Use Scouts to Help Build Future Workforce and Develop a Supportive Academic Engineering Community

Backup – MEPAG MHP SSG Goal IV Revision

MHP SSG Draft Goal IVA - Measurements

The following four investigations are of indistinguishable high priority

- 1A. Characterize the particulates that could be transported to mission surfaces through the air (including both natural aeolian dust and particulates that could be raised from the martian regolith by ground operations), and that could affect hardware's engineering properties.
- 1B. Determine the atmospheric fluid variations from ground to >90 km that affect EDL and TAO including both ambient conditions and dust storms.
- 1C. Determine if each martian site to be visited by humans is free, to within acceptable risk standards, of replicating biohazards which may have adverse effects on humans and other terrestrial species.
- 1D. Characterize potential sources of water to support ISRU for eventual human missions.

MHP SSG Draft Goal IVA - Measurements

The following investigations are listed in descending priority order

- 2. Determine the possible toxic effects of martian dust on humans.
- 3. Derive the basic measurements of atmospheric electricity that affects TAO and human occupation.
- 4. Determine the processes by which terrestrial microbial life, or its remains, is dispersed and/or destroyed on Mars (including within ISRU-related water deposits), the rates and scale of these processes, and the potential impact on future scientific investigations.
- 5. Characterize in detail the ionizing radiation environment at the martian surface, distinguishing contributions from the energetic charged particles that penetrate the atmosphere, secondary neutrons produced in the atmosphere, and secondary charged particles and neutrons produced in the regolith.
- 6. Determine traction/cohesion in martian soil/regolith (with emphasis on trafficability hazards, such as dust pockets and dunes) throughout planned landing sites; where possible, feed findings into surface asset design requirements.
- 7. Determine the meteorological properties of dust storms at ground level that affect human occupation and EVA.

MHP SSG Draft Goal IVB – Tech/Infrastructure

- **1A. Conduct a series of three aerocapture flight demonstrations:**
  - 70 deg sphere cone shape (robotic scale) to demonstrate aerocapture at Mars (Early).
  - New entry vehicle configuration suitable for human exploration (robotic scale) aerocapture at Mars (Mid).
  - New entry vehicle configuration suitable for human exploration (larger scale, end-to-end mission sequence) aerocapture at Mars (Late)
- **1B. Conduct a series of three in-situ resource utilization technology demonstrations:**
  - (1) ISRU Atmospheric Processing (Early)
  - (2) ISRU Regolith-Water Processing (Early)
  - (3) ISRU Human-Scale Application Dress Rehearsal (Late)
- **1C. Demonstrate an end-to-end system for soft, pinpoint Mars landing with 10m to 100m accuracy using systems characteristics that are representative of Mars human exploration systems. (Mid)**

MHP SSG Draft Goal IVB – Tech/Infrastructure

- **2A. Emplace continuous and redundant in-situ communications/navigation infrastructure (Late)**
- **2B. Investigate long-term material degradation over times comparable to human mission needs. (Mid)**
- **3. Develop and demonstrate accurate, robust and autonomous Mars approach navigation. (Mid)**